

CLAIMS

What is claimed is:

- 1 1. A piston/cylinder unit, comprising:
2 a closed cylinder defining a cylinder interior;
3 a piston axially displaceably guided in said closed cylinder and having an
4 annular seal, said piston dividing said cylinder interior into first and second working
5 spaces, each of said first and second working spaces being filled with hydraulic fluid;
6 a piston rod connected to said piston, said piston rod extending through
7 the cylinder interior and sealingly guided to the outside of the cylinder through a closing
8 wall of said cylinder;
9 a first nonreturn valve arranged in said piston and having a first closing
10 element which is force-loaded in a closing direction toward a closed position, said first
11 closing element being openable for connecting said first working space to said second
12 working space when a pressure in said first working space exceeds a first opening
13 pressure; and
14 a second nonreturn valve arranged in said piston and having a second
15 closing element which is force-loaded in a closing direction toward a closed position,
16 said second closing element being openable for connecting said second working space
17 to said first working space when a pressure in said second working space exceeds a
18 second opening pressure,
19 wherein a surface area of one of said first and second closing elements
20 that is acted upon by a pressure in the respective one of said first and second working
21 spaces increases when said one of said first and second closing elements moves along
22 an opening stroke from the closed position toward an open position.
- 1 2. The piston/cylinder unit of claim 1, wherein said one of said first
2 and second nonreturn valves comprises a stepped piston which is arranged
3 displaceably in a corresponding stepped hole defined in said one of said first and
4 second nonreturn valves, said stepped piston having steps with end-side surfaces

5 which can be acted upon effectively by the pressure of the respective one of said first
6 and second working space comprising a smallest step and a further step, only said first
7 step being pressurized in the closed position, said further step being pressurized when
8 said closing element is moved along said opening stroke away from said closed
9 position.

1 3. The piston/cylinder unit of claim 2, wherein at least the smallest
2 surface of the one of said first and second nonreturn valves that is acted upon by the
3 pressure of the respective one of said first and second working spaces comprises a
4 closing element of a seat valve.

1 4. The piston/cylinder unit of claim 3, wherein said closing element of
2 a seat valve is movable onto a mouth of the smallest step of the stepped hole, said
3 mouth forming a valve seat of said one of said first and second nonreturn valves, the
4 smallest step of said stepped hole being in communication said working space.

1 5. The piston/cylinder unit of claim 4, wherein said closing element
2 has a conical closing surface movable onto said valve seat.

1 6. The piston/cylinder unit of claim 3, wherein said closing element
2 includes a closing surface made of an elastomer.

1 7. The piston/cylinder unit of claim 2, wherein at least one step of the
2 steps in said stepped hole have a connection to a next-larger step of the steps in said
3 stepped hole, wherein said connection is openable when a position along the opening
4 stroke is reached by said stepped piston.

1 8. The piston/cylinder unit of claim 7, wherein at least one of the steps
2 of said stepped piston forms a slide of a slide valve for selectively closing said
3 connection in the stepped hole.

1 9. The piston/cylinder unit of claim 8, wherein at least one of the steps
2 of said stepped piston have an encircling annular groove on a cylindrical circumferential
3 surface, a sealing ring being inserted in said encircling annular groove, the sealing ring
4 sealingly bearing against an inner wall of the corresponding step of said stepped hole.

1 10. The piston/cylinder unit of claim 7, further comprising a radial
2 connection leading from a largest step of said stepped hole into an annular cylinder
3 space defined between an inner wall of said cylinder and an encircling circumferential
4 surface of said piston, said annular seal of said piston comprising two annular seals
5 sealing said annular cylinder space with respect to said first and second working
6 spaces, said radial connection being closeable by the largest step of said stepped
7 piston and openable in a fully open position of said stepped piston along the opening
8 stroke.

1 11. The piston/cylinder unit of claim 1, further comprising a
2 compression spring loading the one of said first and second closing elements
3 corresponding to said one of said first and second nonreturn valves in the closing
4 direction, said spring being supported on said piston.

1 12. The piston/cylinder unit of claim 11, wherein said compression
2 spring comprises one of a helical compression spring and a disc spring.

1 13. The piston/cylinder unit of claim 10, wherein the largest step of said
2 stepped hole defines a damping chamber which is connected to said annular cylinder
3 space by a damping opening in said piston, said damping chamber being on a side of
4 said stepped piston facing away from the one of said first and second working
5 chambers.

1 14. The piston/cylinder unit of claim 13, wherein said damping chamber
2 is connectable to said cylinder space by a valve when said stepped piston is moved
3 toward the closed position.

1 15. The piston/cylinder unit of claim 14, wherein said valve comprises a
2 sealing ring arranged in an annular groove formed on the cylindrical circumferential
3 surface of the largest step of said stepped piston, a side of said sealing ring facing away
4 from said damping chamber being connected to said cylinder space such that a flow
5 passes said sealing ring from said cylinder space to said damping chamber when said
6 stepped piston is moved toward the closed position.

1 16. The piston/cylinder unit of claim 10, further comprising a
2 compression spring loading the one of said first and second closing elements
3 corresponding to said one of said first and second nonreturn valves in the closing
4 direction, wherein said compression spring is arranged in said damping chamber.

1 17. The piston/cylinder unit of claim 2, wherein the largest step of said
2 stepped hole is connected on the side of the corresponding step of said stepped piston
3 which faces the one of said first and second working chambers, to the cylinder space by
4 a constricting opening.

1 18. The piston/cylinder unit of claim 1, wherein said annular seal is
2 arranged in an annular groove which is formed on the cylindrical circumferential surface
3 of the piston.

1 19. The piston/cylinder unit of claim 1, wherein said annular seal
2 comprises a radially encircling sealing lip having a free end directed approximately
3 towards the one of said first and second working spaces, said free end bearing
4 resiliently against an inner wall of said cylinder.

1 20. The piston/cylinder unit of claim 2, wherein said at least one
2 stepped hole is defined by a passage hole of a pipe and is directed towards said
3 damping chamber, wherein the smallest step of said stepped piston is displaceably

4 arranged in said passage hole, a collar-like region of said stepped piston engaging
5 around a region of said pipe.

1 21. The piston/cylinder unit of claim 20, wherein an end region of said
2 pipe facing said damping chamber includes radially continuous slots which form a radial
3 connection between two steps of said stepped hole.

1 22. The piston/cylinder unit of claim 2, wherein said stepped piston
2 comprises an elastomeric material formed integrally with a closing surface of the closing
3 element.

1 23. The piston/cylinder unit of claim 22, wherein said stepped piston
2 further comprises radially encircling sealing lips on one or more of the steps of said
3 stepped piston.

1 24. The piston/cylinder unit of claim 2, comprises an elastomeric
2 material formed integrally with radially encircling sealing lips on one or more of the steps
3 of said stepped piston.

1 25. The piston/cylinder unit of claim 1, wherein said piston rod
2 comprises a one-sided piston rod and said piston comprises a volume control chamber
3 for receiving the amount displaced from the second working space remote from said
4 piston rod, which amount is larger than the amount displaced from said first working
5 space on the piston-rod side.

1 26. The piston/cylinder unit of claim 25, wherein the volume control
2 chamber is arranged between said first and the second nonreturn valves in said piston
3 and is connected to an annular cylinder space defined between an inner wall of said
4 cylinder and an encircling circumferential surface of said piston between the first and
5 the second nonreturn valves, the connectiojn being made through an inlet opening.

1 27. The piston/cylinder unit of claim 1, wherein a valve passage defined
2 by said one of said first and second closing elements in a first part of the opening stroke
3 of said one of said first and second nonreturn valves is a constricting passage.

1 28. The piston/cylinder unit of claim 27, wherein said one of said first
2 and second nonreturn valves comprises a stepped piston which is arranged
3 displaceably in a corresponding stepped hole defined in said one of said first and
4 second nonreturn valves, said stepped piston having steps with end-side surfaces
5 which can be acted upon effectively by the pressure of the respective one of said first
6 and second working space comprising a smallest step and a further step, only said first
7 step being pressurized in the closed position, said further step being pressurized when
8 said closing element is moved along said opening stroke away from said closed
9 position, wherein at least the smallest surface of the one of said first and second
10 nonreturn valves that is acted upon by the pressure of the respective one of said first
11 and second working spaces comprises a closing element of a seat valve, and wherein
12 said constricting passage is arranged upstream and/or downstream of said valve seat of
13 said seat valve relative to the direction of flow between said first and second working
14 spaces.

1 29. The piston/cylinder unit of claim 28, wherein said closing element of
2 a seat valve is movable onto a mouth of the smallest step of the stepped hole, said
3 mouth forming a valve seat of said one of said first and second nonreturn valves, the
4 smallest step of said stepped hole being in communication said working space, and
5 wherein said stepped piston has an approximately cylindrical extension directed from
6 said one of said first and second closing elements to the corresponding one of said first
7 and second working spaces, said cylindrical extension protruding through said smallest
8 step of said stepped hole, wherein the constricting passage is defined by an annular gap
9 between the encircling circumferential surface of said cylindrical extension and the inner
10 wall of the smallest step of the stepped hole.

1 30. The piston/cylinder unit of claim 28, wherein a step of said stepped
2 piston on a side of said valve seat facing away from said corresponding one of said first
3 and second working space comprises a cylindrical extension, said base defining an
4 annular collar protruding into the second step of said stepped hole in the opening
5 direction of said one of said first and second nonreturn valves for guiding said cylindrical
6 extension, an annular gap defined between the encircling circumferential surface of said
7 cylindrical extension and an inner wall of said annular collar forming the constricting
8 passage.